# THE VEGETATIONAL GRADIENT ON THE LOWER SLOPES OF THE SIERRA SAN PEDRO MARTIR IN NORTHWEST BAJA CALIFORNIA

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The coastal plains of northwestern Baja Califorina are covered with a unique vegetation which has interested botanists through the years. Shreve (1936) considered this vegetation, which covers a 100 mile extent roughly between Ensenada and Rosario, as a distinctive transitional type between the desert scrub of the south and the chaparral (the dense evergreen sclerophyllous scrub characteristic of Mediterranean type climates) of the north. He viewed the vegetation as transitional primarily in the sense that it has ecological features, in terms of cover, life form, and leaf types, intermediate between desert scrub and chaparral. Floristically, however, he stated that the vegetation was distinctive because of the large number of prominent endemics including, for example, *Aesculus parryi, Adolphia californica, Bergerocactus emoryi,* and *Rosa minutifolia.*

Epling and Lewis (1947) briefly discussed this vegetation in their comprehensive floristic view of the chaparral and coastal sage (a shrubby vegetation type which is lower in stature than the chaparral, and which is composed of primarily drought-deciduous elements) vegetation types. They state that the coastal sage vegetation, which is confined primarily to the California coastal regions at elevations below the chaparral, extends from the San Francisco Bay Region of central California southward to Rosario in Baja California. This would then include the transitional type of Shreve. Epling and Lewis (1947) noted that many of the transition zone endemics, particularly the woody elements, ". . . do not seem to form an integral part either of the coastal sage or the chaparral—but seem to hold themselves somewhat apart. . . ." They felt that Shreve's interpretation of the transitional type was somewhat confused because of his failure to recognize the identity of the coastal sage vegetation and its ecological position relative to the chaparral.

Neither Shreve nor Epling and Lewis visited the vegetation lying inland from the coastal plains on the slopes of the Sierra San Pedro Martir although they felt this region might be critical to an understanding of the so-called transition vegetation.

The present study examines some of the ecological characteristics of the coastal lowland vegetation as it compares with the vegetation on the lower slopes of the Sierra San Pedro Martir, including the chaparral.

## The Study Area and Sampling Methods

The vegetation was examined in a west-to-east transect in the foothill region between San Telmo and Valladares Rancho. This region of the Sierra San Pedro Martir is located at approximately 31°S. The highest elevation encountered, near the eastern end of the transect, was 800 m. Near the base and presumably the driest portion of the transect at San Telmo, which is located at 175 m elevation, average annual precipitation is 160 mm (Hastings, 1964).

Observations of the general vegetational trends were made throughout the transect with quantitative samples at three points: 100, 430, and 800 meters elevation. At the sampling stations three 20-meter line intercepts were utilized. The height and projected cover of each individual on the line were recorded. The cover values given in the results are averages for all sample lines at each station. Presence of species in the general area that were not encountered on the lines was also noted.

## Results

The leaf type (evergreen, drought-deciduous, or stem-succulent) and the percentage cover of each species encountered at the three sample stations are given in Table 1. The number of species decreases with elevation, whereas the total vegetation cover increases. A few species were found at all stations, such as *Rhus laurina, Ephedra californica,* and *Eriogonum fasciculatum.* The first two, however, were only occasional individuals at each site. The low- and mid-elevation sites shared about 20% of their species; the mid- and high-elevation sites somewhat more.

One of the most striking aspects of the vegetational gradient is the shift in leaf type with elevation (fig. 1). Over 35% of the species at the lowest site were succulents, whereas no succulents were present at the highest elevations. Further, the percentage of evergreen species increases greatly with elevation. Eighty per cent of the species are evergreen at the highest elevation site, whereas there are only 20% evergreens at the lowest site. The results are generally similar when considered on the percentage cover of the various leaf types at each site (table 1), rather than the percentage of species present of a given leaf type as is shown in Figure 1. For example, evergreen species constitute 72% of the cover at the 800 m site, and only 7% at the 100 m site. Drought-deciduous species are most prevalent at the mid-elevation site where they constitute over 71% of the species (fig. 1) and 73% of the cover (table 1).

The assessment of leaf type (deciduous vs. evergreen) was made at the end of the drought season in mid-December, 1968. In all cases, except for *Eriogonum fasciculatum,* the leaf type was constant for a given species at all stations. *Erigonum* plants at the lowest sites had only a few terminal green leaves present, whereas at the highest sites they held a large number of apparently functional leaves.

Another vegetational trend with elevation is the increasing stature (and woodiness) of the plants (fig. 2). At the 800 m site most of the

TABLE 1. LEAF TYPE AND PER CENT COVER OF THE PERENNIAL PLANTS ENCOUNTERED IN TRANSECT.*

| | 100 | 400 | 800 |
|---|---|---|---|
| Agave shawii Engelm. | 7.90(S) | | |
| Machaerocereus gummosus (Engelm.) Britt. & Rose | 4.00(S) | | |
| Echinocereus maritimus (M. E. Jones) K. Schum. | 0.25(S) | | |
| Mammillaria dioica K. Brandegee | 0.33(S) | | |
| Bergerocactus emoryi (Engelm.) Britt. & Rose | 1.16(S) | | |
| Dudleya ingens Rose in Britt. & Rose | 0.83(S) | | |
| Myrtillocactus cochal (Orcutt) Britt. & Rose | P (S) | | |
| Opuntia rosarica G. Lindsay | P (S) | | |
| Franseria chenopodifolia Benth. | 17.63(D) | | |
| Euphorbia misera Benth. | 0.41(D) | | |
| Harfordia macroptera (Benth.) Greene & Parry | 1.91(D) | | |
| Lycium californicum Nutt. ex A. Gray | P (D) | | |
| Unknown shrub | P (D) | | |
| Galvezia juncea (Benth.) Ball | P (D) | | |
| Rhus integrifolia (Nutt.) Benth. & Hook. | P (E) | | |
| Rosa minutifolia Engelm. | 15.73(D) | 2.91(D) | |
| Viguiera laciniata A. Gray | P (D) | 15.46(D) | |
| Simmondsia chinensis (Link) Schneider | 7.25(E) | P (E) | |
| Eriogonum fasciculatum Benth. | 0.83(D) | 8.95(D) | 1.66(E) |
| Ephedra californica Wats. | P (E) | 1.45(E) | P (E) |
| Rhus laurina Nutt. in T. & G. | P (E) | P (E) | P (E) |
| Acalypha californica Benth. | | 0.16(D) | |
| Eriogonum sp. | | 0.21(D) | |
| Artemisia californica Less. | | 2.49(D) | |
| Encelia californica Nutt. | | P (D) | |
| Aesculus parryi A. Gray | | P (D) | |
| Salvia munzii Epl. | | 15.83(D) | |
| Lotus scoparius (Nutt. in T. & G.) Ottley | | 27.69(D) | 26.66(D) |
| Cneoridium dumosum (Nutt.) Hook. | | P (E) | 0.41(E) |
| Adenostoma fasciculatum H. & A. | | | 49.41(E) |
| Arctostaphylos oppositifolia Parry | | | 20.66(E) |
| Trichostema parishii Vasey | | | 0.83(E) |
| Fraxinus trifoliata (Torr.) Lewis & Epling | | | 5.00(D) |
| Xylococcus bicolor Nutt. | | | P (E) |
| Juniperus california Carr. | | | P (E) |
| Total % plant cover | 58.23 | 75.15 | 104.63 |
| *Per cent cover by plant leaf types* | | | |
| Stem succulents | 14.47 | 0 | 0 |
| Drought-deciduous | 36.51 | 73.70 | 31.66 |
| Evergreen | 7.25 | 1.45 | 72.97 |

* Numbers refer to percentage plant cover; P notes presence of species. Letters in parentheses refer to plant leaf types: E, evergreen; D, drought-deciduous; and S, stem succulent.

species are greater than 1.5 m tall. In contrast, the lowest site had species of many different size classes, but most were less than 1.5 meters tall.

All of the sites showed some evidence of light grazing. This may explain the importance of such subshrubs as *Lotus scoparius* at the high-elevation chaparral site where it probably is successional and indicates evidence of disturbance. As is often the case to the north, coastal sage

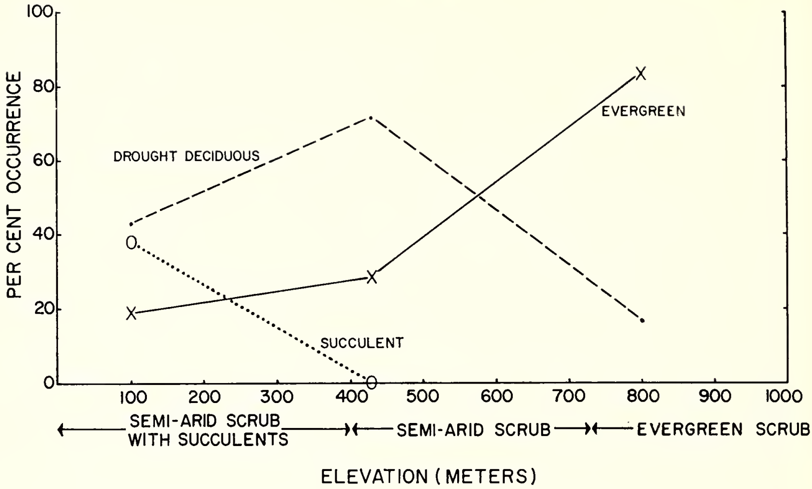


FIG. 1. Percentage of the species occurring at each sample site which are drought deciduous, evergreen, or stem succulent. In order to compare the vegetation types encountered in this study with those found in other Mediterranean climatic regions generalized descriptive terms are used in this figure. Evergreen scrub would correspond to chaparral of the text, semi-arid scrub to coastal sage, and semi-arid scrub with succulents to the "transitional vegetation." The elevational limits of the vegetation types are generalized and apply only to the immediate transect route.

elements may occur as successional species within disturbed areas of the chaparral (Harrison *et al.*, 1971).

## Discussion

The lowest elevation vegetation within the study area is distinctive from the coastal sage vegetation to the north in two regards: 1) the number of endemic species it contains, and 2) the large number of succulents present. More closely allied to the northern coastal sage, both ecologically and floristically, is the vegetation which occurs in the study area between elevations of 400 and 730 m. Here, as in the north, the predominant growth form is a drought-deciduous shrub less than a meter in height. *Artemisia californica, Salvia munzii, Viguiera lacinata, Encelia californica, Eriogonum fasciculatum,* and *Lotus scoparius,* all characteristic of the coastal sage according to Epling and Lewis, are present at mid-elevations. A few of these species also occurred at the other sampling stations but it appears that this southern version of coastal sage vegetation reaches its lower limit near 400 m elevation. Floristically, the picture is difficult to assess in detail because only the dominantts have been considered. More detailed study of the distribution of all floristic elements within this region and in adjacent areas would be useful, but must be analyzed in relation to the complex microhabitat variation of the region. For example, *Heteromeles arbutifolia,* a charac-

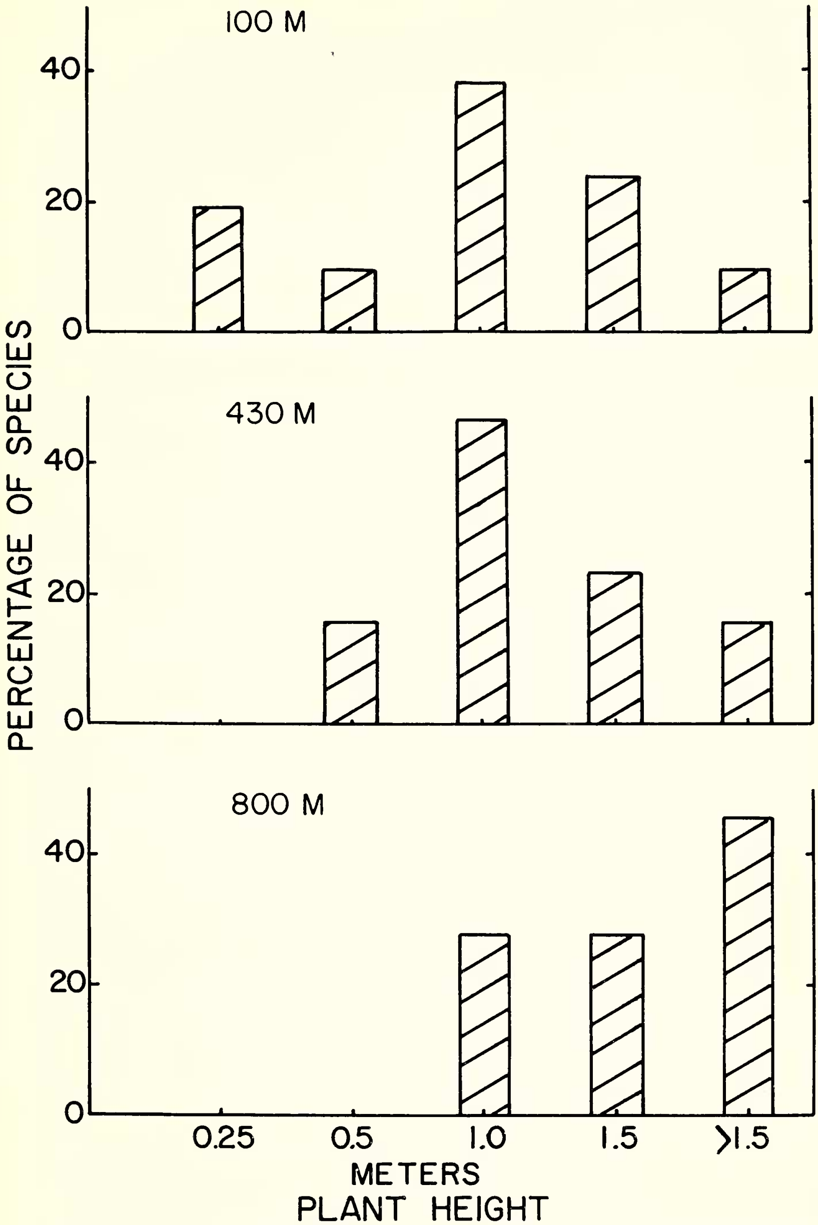


FIG. 2. Frequency distribution of plant heights of all species occurring at sample sites at 100, 430, and 800 meters elevation.

teristic chaparral plant is often found in favorable microsites within a matrix of the more xeric coastal sage elements in this area.

Certain ecological trends are, however, quite clear. Shreve noted a number of tendencies which were apparent going from the desert vegetation at the southern end of the transition type to the chaparral to the north, or in other words, along a gradient of increasing available moisture and decreasing temperatures. These are: 1) an increasing density of the vegetation, 2) an increasing uniformity in the heights of the dominants, and 4) an increasing loss of the drought-deciduous elements and an increase in the evergreens. All of these trends apply in the gradient from the coastal vegetation in the transition area through chaparral vegetation on the mid-elevation slopes of the Sierra San Pedro Martir. Similar ecological changes have also been noted along an altitudinal gradient in the Santa Catalina Mountains of Arizona by Whittaker and Niering (1965).

These altitudinal trends are the same that prevail latitudinally in California and even along comparable climatic gradients in Chile (Mooney *et al.,* 1970). The basis for certain of these trends, particularly growth form and leaf type, has been discussed by Mooney and Dunn (1970), in relation to the photosynthetic economy of the various plant types (evergreen, drought-deciduous, and succulent) and habitat water availability. Such compact gradients encompassing such a wide diversity offer an excellent opportunity for the study of problems relating to ecological variability and adaptation.

The coastal vegetation with its large number of unique and beautiful succulents is unfortunately being rapidly decimated, as is the related coastal sage to the north, due to rapid development in these favorable building and agricultural sites. Hopefully, representative areas can be saved for future study. These areas are particularly rich in the variability of ecological types which they contain. Only limited studies have been made of them at the present.

## Acknowledgements

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# REVIEW

*The Savory Wild Mushroom.* By Margaret McKinney. Revised and enlarged by Daniel E. Stuntz. XXI + 242 pp., illustrated. University of Washington Press, Seattle, Wash. 98105. 1971. $8.95 cloth; $4.95 paperback.

The first edition of this popularly written handbook on the more common species of west coast mushrooms proved so useful and attractive that it soon became out of print. This newly revised edition will undoubtedly prove even more popular since it is considerably enlarged, and the species descriptions are somewhat more detailed. As in the first edition the book is divided into three sections with the first and largest part being devoted to a treatment of approximately 150 species of fleshy fungi followed by a chapter devoted to mushroom poisoning and concluding with two chapters devoted to mycophagy. The format is similar to that of the first edition with each species receiving a short description along with pertinent comments on its distinctive features and edibility. Since it is designed primarily as a field manual all microscopic data are omitted, and no taxonomic keys are included. In the new edition all species of a given group are placed together rather than being artificially divided on the basis of edibility with the result that it is much easier to use. Representatives of most of the major groups of fleshy fungi are included, but the gill fungi receive the most space. A photograph of each species is included many of which are in color. Since Professor Stuntz is the dean of agaricologists on the West Coast, it is not surprising that the species determinations are highly accurate and carefully presented. So far as is known this publication represents the most complete compilation of west coast fungi available.

The most disappointing feature is the generally poor reproduction of the color plates. The colors, particularly the red shades, are badly reproduced as shown in *Amanita muscaria,* for example, which appears dark brown rather than bright red. The black and white photographs are much better but in some the composition and lighting could have been improved. From a taxonomic point of view only a few minor criticisms might be made. At least one new combination has been made without following the International Code. It is now apparent that *Boletus olivaceobrunneus* is not at all related to *Boletus edulis* as indicated in the text but is perhaps synonymous with *Tylopilus pseudoscaber.* Also the photograph of *Boletus eastwoodeae* is somewhat misleading since the more typical variety has a much shorter and darker colored stipe.

The chapter on mushroom poisoning, written by Professor Tyler, is excellent. It is well written, authoritative and should be required reading for all those interested in mycophagy. In a considerably lighter vein is a chapter on edibility and mushroom cookery written by A. M. Pellegrini. It is lively and thoroughly enjoyable and provides a good commentary on the present practices in preparing these fungi for the table. The recipes in the final chapter are essentially the same as in the first edition.—HARRY D. THIERS, Department of Ecology & Systematic Biology, San Francisco State College, San Francisco, California 94132.